

REVIEW RESOURCES

Lesson 19: Test and Evaluation Overview

Why Test and Evaluate?

Information is critical to managing an acquisition program. This includes information on the capabilities and limitations of the system and risks affecting system cost, development schedule, and performance. The overall goal of T&E is to reduce risk by providing crucial information to decision makers.

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T&E Mandates

DOD Directive 5000.1 provides guidance on how T&E programs shall be structured. Paragraph 1.d.2.e requires that programs be structured to:

- Provide essential information to decision makers;
- Assess attainment of technical performance parameters; and
- Determine whether systems are operationally effective, suitable and survivable.

DOD Regulation 5000.2-R states that test activities shall be part of a strategy to:

- Provide information regarding risk and risk mitigation,
- Provide empirical data to validate models and simulations, and
- Permit an assessment of the attainment of technical performance specifications and system maturity.

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T&E Customers

These Customers:	Use T&E Information to:
Acquisition Managers	<ul style="list-style-type: none"> • Evaluate the acquisition program for risk management. • Determine if system performance meets thresholds. • Determine if the system has the potential to meet objectives. • Determine the technical changes needed to keep the program on track.
Designers and Engineers	<ul style="list-style-type: none"> • Evaluate system design and performance. • Identify if design changes are needed. • Provide feedback into Systems Engineering Process. • Update modeling and simulation.
End-users	<ul style="list-style-type: none"> • Learn how the system performs under operational conditions. • Utilize operational performance characteristics to improve tactics

- Utilize operational performance characteristics to improve tactics and warfighting capability.
- Obtain information to help plan for training and logistics support.
- Understand full performance envelope and capabilities.

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Defining Test and Evaluate

TERM

DEFINITION

Test

A program, procedure, or process to obtain, verify, or provide data for determining the degree to which a system (or subsystem) meets, exceeds, or fails to meet its stated requirements. These requirements can be stated in terms of thresholds and objectives. Testing:

- Obtains raw data.
- Measures specific, individual performance factors (e.g., measuring range).
- Is resource intensive.

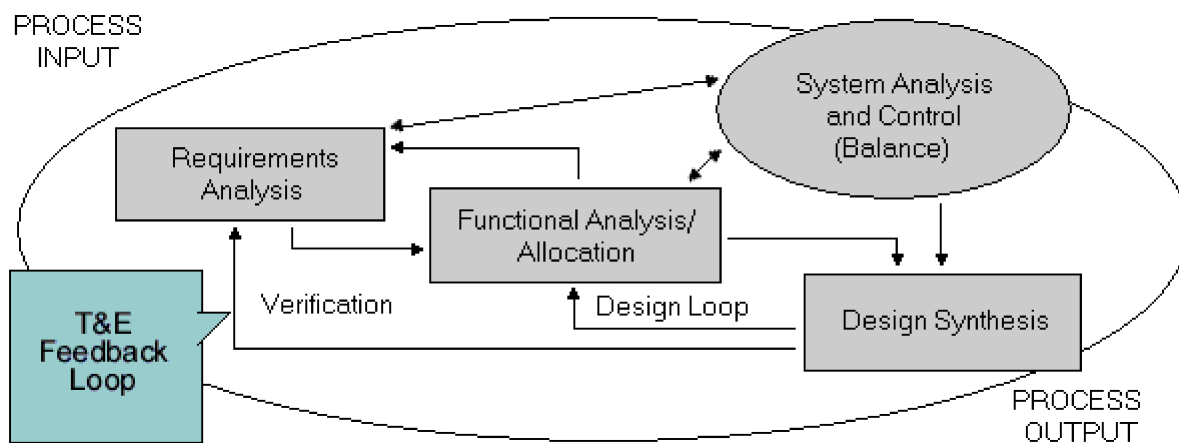
Evaluate

Reviewing, analyzing, and assessing data obtained from testing to project system performance under operational conditions. Evaluating:

- Produces analyzed information from test data, modeling and simulation, or other sources.
- Draws conclusions by looking at how the factors interact.
- Is intellectually intensive.

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T&E Feedback Loop



T&E is the essential feedback loop contained within the Systems Engineering Process. T&E ensures that the system meets the requirements. The T&E process is repeated as the system evolves from

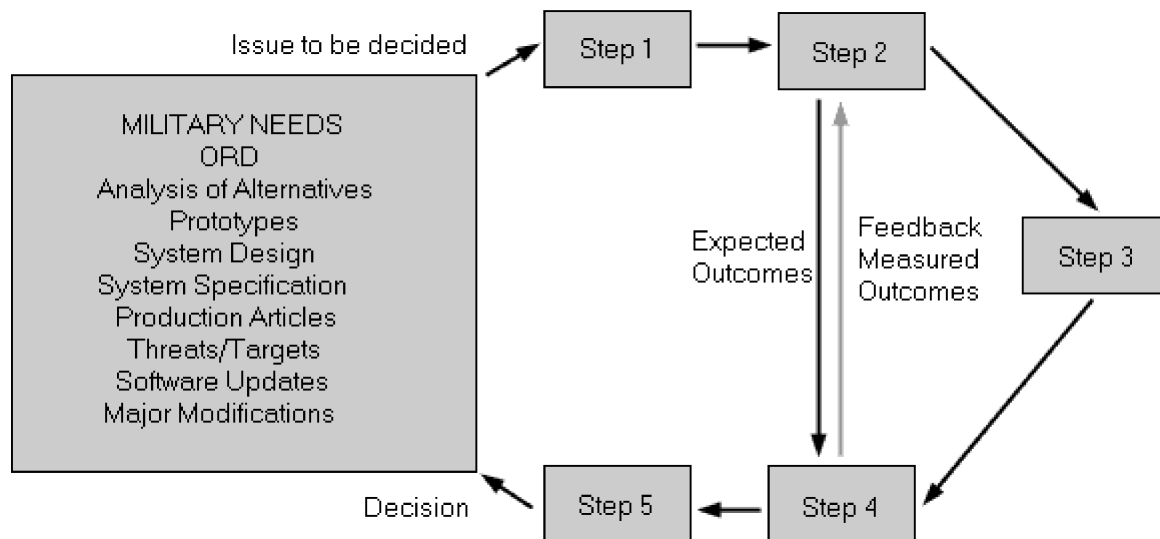
models to components to production articles and complete systems.

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Test and Evaluation Process Overview

The T&E process has five steps that occur as we evaluate important information within the acquisition process.



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Five Steps in the T&E Process

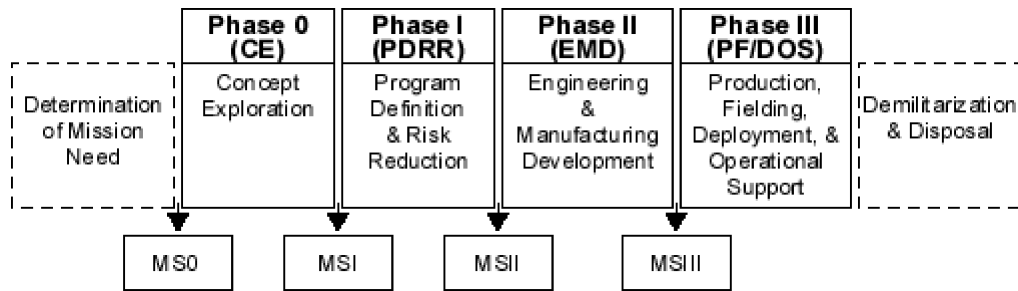
STEP	DESCRIPTION
1	Identify critical issues and data requirements.
2	Pre-test engineering analysis by the evaluation and the development of an evaluation plan. Expected outcomes are predicted.
3	The test is planned and conducted. Data are retrieved and analyzed. Data may be collected from other means such as Modeling and Simulation (M&S), training, etc.
4	A post-synthesis step in which an evaluation report of data is compiled. Predictions from Step 2 are compared with actual measured outcomes.
5	T&E results are balanced with other available program information. The appropriate programming decision is made.

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T&E and the Acquisition Life Cycle

T&E activities occur throughout the acquisition life cycle. T&E results are required during each phase to support the next milestone decision.



Milestone 0 Review

Key Milestone 0 Review Activities:

- Need is validated and reviewed.
- Authorization is granted to proceed to Phase 0.
- Exit criteria for Phase 0 are determined.

In support of Milestone 0, T&E personnel may supplement battle labs and experimental programs to determine program warfighting requirements; however, no actual system testing occurs before Milestone 0 review. Early T&E begins in Phase 0.

Milestone I Review

Key Milestone I Review Activities:

- Analysis of Alternatives is reviewed.
- Most promising systems concepts are selected.
- New acquisition program is authorized.
- Exit criteria for Phase I are determined.

In support of Milestone I during Phase 0, T&E personnel:

- Determine the testability of the exit criteria.
- Develop a Test and Evaluation Master Plan (TEMP), which will include a top-level T&E strategy and identify major test objectives, test events, simulations, resources, and timing.
- Confirm that Phase 0 exit criteria relative to T&E are met.
- Assist the program office in evaluating top-level system digital models that will be used and refined throughout system development.

Milestone II Review

Key Milestone II Review Activity:

- Decision is made to enter into full-rate production.

In support of Milestone II during Phase I, T&E personnel provide data confirming that:

- Performance of system components and overall design satisfy mission requirements.
- Performance meets Phase I exit criteria.
- Performance of early prototypes and engineering development models is validated.
- System models are verified and validated.
- Virtual prototypes accurately represent system performance.

Milestone III Review

Key Milestone III Review Activities:

- Decision is made to proceed with full-scale engineering and manufacturing development.
- Most promising systems concepts are selected.

In support of Milestone III during Phase II, T&E personnel:

- Collect critical data on the effectiveness, suitability, and survivability of the system.
- Analyze data and provide decision makers with information to help them decide whether to produce and deploy the system.
- Evaluate Phase II exit criteria.
- Complete Live Fire and Initial Operational T&E.
- Refine and validate Modeling and Simulation (M&S) tools with test data from prototypes.

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Developmental T&E (DT&E)

DT&E is conducted throughout the life cycle to:

- Identify potential operational and technological capabilities and limitations of alternative design concepts and options.
- Support identification of cost-performance trade-offs.
- Support identification and description of design technical risks.
- Assess progress toward meeting critical technical parameters.
- Provide data and analysis to support the decision to certify the system is safe and ready for operational T&E.
- Assist the program office in finding fixes to performance problems.

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Operational T&E (OT&E)

OT&E are field tests conducted under realistic operational conditions of any item (or key component) of weapons, equipment, or munitions to:

- Determine the effectiveness and suitability of the systems for use in combat by typical military users.
- Provide decision makers with an evaluation of such test results.

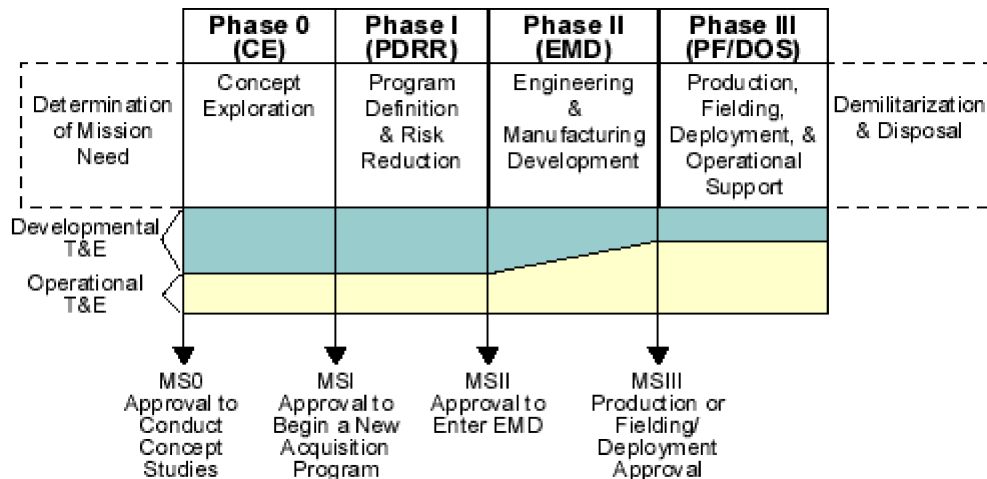
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Contrasting DT&E Versus OT&E

	DT&E	OT&E
What is Tested?	Measures technical performance against the design specifications in a controlled environment.	Determines operational effectiveness and suitability as defined in the Operational Requirements Document (ORD).
Who Conducts Test?	Government and contractor	Government
Who is Responsible?	Program Manager	Independent Operational Testing Agency (OTA)

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Types of Testing and the Life Cycle

T&E is continuous throughout the life cycle with early emphasis on DT&E. Later, emphasis shifts to OT&E as the system design becomes more stable. Both types of testing can occur throughout the life cycle.


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A Closer Look at DT&E

DT&E has the following major purposes:

- Serves as a feedback loop within the Systems Engineering Process.
- Identifies and mitigates technical design risks.
- Measures technical performance (thresholds and objectives) and contract specification compliance.
- Updates and validates models and simulations.

Performance and Environmental Factors

DT&E assesses performance under a number of environmental parameters. Listed below are examples of performance factors and environmental factors considered during DT&E.

Performance:

- Accuracy
- Maneuverability
- Interoperability
- Material Strength
- Reliability
- Maintainability
- Software Integration
- Software Functionality

Environmental:

- Temperature
- Pressure
- Vibration
- Shock
- Humidity
- Sea Salt Spray
- Rain, Snow, Ice
- Lightning

DT&E Requirements

In the DT&E requirements generation process:

- The Government establishes requirements using such documents as the:
 - Operational Requirements Document (ORD),
 - System Threat Analysis (STA),
 - Test and Evaluation Master Plan (TEMP), and
 - Analysis of Alternatives (AoA).
- DT&E requirements are communicated to contractors through such contract documents as the:
 - Statement of Work (SOW),
 - Statement of Objectives (SOO),
 - System Specifications, and
 - Work Breakdown Structure (WBS).
- The contractor establishes subsystem DT&E requirements and communicates them to each subcontractor.

Contractor's Role in DT&E

The contractor:

- Develops and delivers, for Government approval, an Integrated Test Plan (ITP), when required by the PM.
- Conducts sufficient testing before delivery to the Government.
- Provides technical support to Government T&E personnel.
- Corrects deficiencies discovered through testing.
- Helps to minimize testing redundancy.

Special Types of DT&E

Two specific types of DT&E are Production Acceptance T&E (PAT&E) and Live Fire T&E (LFT&E). Production Acceptance T&E is used to verify that each production unit meets contract requirements. It is usually conducted at the contractor's facility. The Defense Contract Management Command (DCMC) may provide oversight. Other Government personnel representing the developer and/or the user may also observe this testing. Live Fire T&E provides a realistic assessment of weapon platform/crew vulnerability and lethality of conventional munitions/missiles. LTF&E is required for all ACAT I and II programs or modifications that impact the system's vulnerability or lethality in combat. It is mandated by Congress, and funded by the program office. Results must be reported to Congress prior to a Milestone III Review decision.

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A Closer Look at Operational T&E

Purpose

Operational T&E (OT&E) assesses the system or components under realistic conditions to determine operational effectiveness and operational suitability.

Operational Effectiveness and Suitability

Operational effectiveness is the degree of mission accomplishment achieved when a system is used by representative personnel in the environment planned or expected for operational employment of the system. Factors taken into account to assess operational effectiveness include:

- Organizational Aspects
- Doctrine

- Tactics
- Survivability
- Vulnerability
- Threat

Operational suitability is the degree to which a system can be placed satisfactorily in field use. Factors taken into account to assess operational suitability include:

- Reliability
- Supportability and Maintainability
- Availability
- Compatibility
- Interoperability
- Safety
- Human Factors and Training
- Transportability
- Wartime Usage Rates
- Documentation

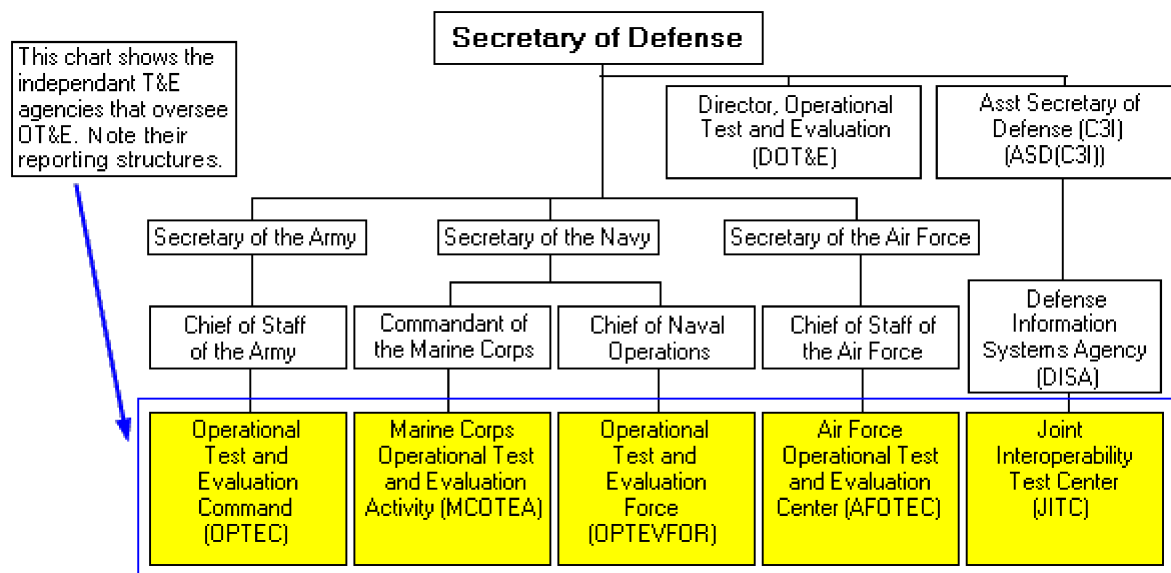
Importance of Independent T&E

While operational field personnel may perform OT&E activities under "typical" operational conditions, OT&E is overseen by an independent Operational Test Agency (OTA) within each service.

Independent assessment is critical to ensure objectivity in determining if operational performance effectiveness and suitability requirements specified in the ORD have been met.

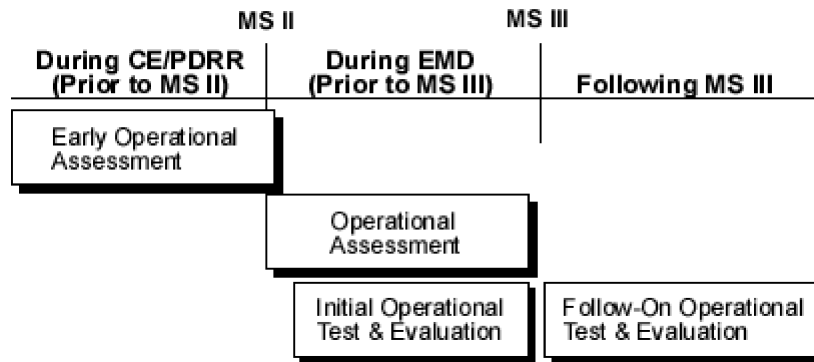
Independent Operational Test Agencies (OTAs)

The organizations in the shaded boxes oversee OT&E.



OT&E Process

The type of OT&E conducted depends on the maturity of the system design and acquisition strategy.



Type of OT&E Test

Description

Early Operational Assessment (EOA)

Performed on prototypes developed during the Program Definition and Risk Reduction (PDRR) phase to help decision makers assess the proposed concepts.

Operational Assessment (OA)

Conducted during the Engineering and Manufacturing Development (EMD) phase. Assesses the system's potential to meet mission requirements and supports a Low Rate Initial Production (LRIP) decision.

Initial Operational Test and Evaluation (IOT&E)

Conducted on production or production representative articles to support a Milestone III Review decision for entering into full-rate production and development.

Follow-On Operational Test and Evaluation (FOT&E)

Conducted after Milestone III Review and may continue throughout the life cycle. Confirms correction of deficiencies noted in IOT&E; develops tactics and doctrine for the new system; evaluates major modifications and/or changes to the system.

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T&E Planning

Importance of T&E

T&E can be expensive and sometimes dangerous, so extensive planning is required. Typical T&E planning activities include:

- Determining types and quantity of data to be collected.
- Estimating the anticipated test risks/results through simulation and modeling.
- Establishing safe test procedures.
- Ensuring environmental protections are in place.
- Projecting resource and schedule requirements.

T&E Planning and Teamwork

T&E information helps the IPT make a variety of decisions, including:

- Planning Decisions: What T&E should be performed?
- Management Decisions: Is the system ready for production?
- Design Decisions: How can we improve performance?
- Contractual Decisions: Does it work as specified?
- Logistical decisions: What types of operator training are needed?

T&E activities can affect IPT members' work schedules and resources. Therefore, T&E planning must involve all IPT members.

Test and Evaluation Master Plan (TEMP)

The Test and Evaluation Master Plan (TEMP) provides an overall test management plan and framework within which detailed T&E plans are contained. DOD 5000.2-R requires that a TEMP be produced for all ACAT I and IA programs and other programs designated for OSD test and evaluation oversight. While TEMP's are not required for other programs, the TEMP format and procedures can be used at the discretion of the Milestone Decision Authority on these programs.

TEMP Requirements

The TEMP must:

- Integrate T&E with the overall acquisition strategy.
- Reflect the user's requirements, and describe how these requirements will be tested in DT&E and OT&E.
- Document the T&E program for the entire life cycle.
- Specify personnel, funding, and test range support requirements.
- Be developed prior to Milestone I Review and updated before each subsequent Milestone Review.

TEMP Source Documents

For developing a TEMP, T&E personnel use such validated and approved requirements documents as the:

- **Mission Need Statement (MNS)**

The Mission Need Statement identifies the overall requirement or threat, and the need for a materiel solution to address the requirement. T&E personnel use the MNS to determine the overall need and to assess what general types of tests and test resources will be needed during the T&E activities. T&E personnel must also be aware of changes in the ongoing nature of the threat or deficiency to determine if the user need has changed during the time the system is under development.

- **Operational Requirements Document (ORD)**

The Operational Requirements Document describes the system solution selected to meet the mission need. The ORD is an important resource for T&E personnel. Because the ORD is a definitive statement of the user need, it serves as a primary source of operational testing requirements.

The critical user needs are expressed in terms of minimum acceptable operational performance requirements, which are described with both threshold and objective values. The T&E community will be asked to test and evaluate whether the threshold values are being met, and also determine the feasibility of enhancing performance up to the objective values.

The ORD is also the source of some key program schedule parameters, including the date of initial operational capability (IOC) and the date of full operational capability (FOC). The IOC date defines the length of the development program, which will affect the size and extent of the test program.

- **System Threat Analysis (STA)**

The Systems Threat Analysis describes the threat to be countered and the projected threat environment. T&E personnel must also be aware of changes in the ongoing nature of the threat to determine whether the system operates effectively within the projected threat environment.

- **Acquisition Program Baseline (APB)**

The Acquisition Program Baseline specifies system performance, cost, and schedule requirements that must be met to ensure the acquisition program remains on track. The APB provides key technical performance parameters that the system is required to attain. T&E personnel developing a TEMP can use the APB parameters as the most definitive statement of the system performance requirements.

- **Analysis of Alternatives (AoA)**

The Analysis of Alternatives evaluates a range of proposed approaches to satisfy the mission need. T&E personnel use the system performance requirements stated within the AoAs as a basis for selection of the T&E activities. The system performance requirements stated as functional objectives are broken down into measures of effectiveness, suitability, and performance. T&E personnel use these measures to identify what elements can be evaluated, and select the specific tests required to demonstrate the required system performance. TEMP developers must review these specific performance parameters to determine whether they are accurate and whether they can be evaluated.

TEMP Contents

The mandatory TEMP format includes:

- **Part I - System Introduction**

The System Introduction section provides an overview description of the system, describing what it is, what it is supposed to do, and key areas for testers to concentrate on.

- **Part II - Integrated Test Program Summary**

The Integrated Test Program Summary provides an overview of the T&E program and schedule. This summary includes two sections. The Integrated Test Program Schedule is a timeline depicting the sequence of the critical test and evaluation phases and events, and the program milestones they support. The Management Section describes the responsibility of all participating organizations within the T&E program.

- **Part III - Developmental Test and Evaluation Outline**

This section provides an overview-level description of the proposed Developmental Test and Evaluation (DT&E) activities. This includes both the DT&E Overview and Future DT&E sections. The DT&E Overview explains how DT&E will verify the status of the engineering design and development process, verify design risks have been minimized, substantiate achievement of contract technical performance requirements, and be used to certify readiness for dedicated operational testing. The Future DT&E section discusses all remaining DT&E that is planned.

- **Part IV - Operational Test and Evaluation Outline**

The Operational Test and Evaluation Outline is usually written by the service independent

Operational Test Agency (OTA).

- **Part V - Test and Evaluation Resource Summary**

The Test and Evaluation Resource Summary lists all key test and evaluation resources, both Government and contractor, that will be used during the course of the test program. Any resource shortfalls that may result in significant test limitations are identified, along with planned corrective actions.

The estimates within the preliminary TEMP are updated and revised throughout the acquisition life cycle to reflect any changes in system concept, resource requirements, or threat assessments.

Unique TEMP Terms

Term	Definition
Critical Operational Issues (COIs)	Top-level issues that must be examined in OT&E to determine the systems capability to perform its mission. COIs are included in Part IV of the TEMP. COIs are categorized in terms of effectiveness and suitability.
Critical Technical Parameters (CTPs)	Engineering design factors that a system must meet or exceed to ensure that established performance thresholds are achieved. They are derived from the ORD, critical system characteristics, and systems engineering documents. CTPs are listed in a matrix, along with the performance objectives and thresholds in Part I of the TEMP.
Measures of Effectiveness and Suitability (MOEs & MOSS)	Performance capabilities and characteristics identified in the ORD and AoA. They appear in Part I of the TEMP and are used to determine the attainment of the top-level performance issues.

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